NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, DC

# NASA ADVISORY COUNCIL

**February 5, 2009**

**Hilton Cocoa Beach Oceanfront**
**Cocoa Beach, Florida**

## MEETING MINUTES

**Marguerite Broadwell**
**Executive Director**

**Kenneth M. Ford**
**Chair**

# NASA ADVISORY COUNCIL
## Hilton Cocoa Beach Oceanfront
## Cocoa Beach, Florida
## February 5, 2009

## MEETING REPORT
## TABLE OF CONTENTS



*Meeting Report Prepared by:*
*Sallie Birket Chafer*

# NASA ADVISORY COUNCIL
## Hilton Cocoa Beach Oceanfront
## Cocoa Beach, Florida
## February 5, 2009

### OPENING REMARKS

NASA Advisory Council (Council or NAC) Chair Dr. Ken Ford opened the public session of the 2009 first quarterly meeting, held at Kennedy Space Center (KSC). He welcomed attendees and thanked KSC Director Bob Cabana and his staff for their logistics assistance. He reminded the Council and the audience that this session is open to the public and held in accordance with the Federal Advisory Committee Act. He noted hard-copy availability of minutes from the fourth quarterly meeting in October 2008; NASA responses to Council recommendations from that meeting; biographies of new NAC members Dr. Alex Levis and Dr. Michael Turner and the new NAC Executive Director Marguerite Broadwell; and a roster of the complete NAC membership.

### SPACE OPERATIONS COMMITTEE: REPORT AND DISCUSSION

Colonel Eileen Collins, Chair of the Council's Space Operations Committee, presented its report, which focused on the International Space Station (ISS) laptop upgrade, an extravehicular activity (EVA) workshop co-chaired by former Council Chair Senator Harrison Schmitt at the Institute for Human and Machine Cognition, the Space Exploration Technologies Limited (SpaceX) facility, ISS status, the Commercial Resupply Service, Shuttle extension update, a Safety and Mission Assurance (SMA) case study training brief, and two recommendations.

**ISS Laptop Upgrade.** Colonel Collins described the Committee's visit to the Johnson Space Center (JSC) Avionics and Software Office to assess the ISS laptop upgrade. The ISS has 81 laptops, mostly obsolete IBM A31Ps. She noted that the crew could use 50 more because these computers directly support the ISS mission, providing crucial services such as rendezvous, robotics, scientific experiment monitoring, video monitors, spacecraft systems, and personal crew use. A number of T61Ps are being certified for space flight, and the first ones will launch in the spring. These new units are lighter and less costly, have more memory (4 GB), use less power, have high-definition video monitor screens, and offer a 6-year useful life. All ISS international partners (Russia, Europe, and Japan) use the same model. Colonel Collins observed that this upgrade is relevant because the ISS is funded only through 2016 in the NASA budget. Recognizing significant ISS potential, the Committee is investigating possible U.S. and international partner uses through 2020 and is studying crew tasks and life.

The Committee also visited the Neutral Buoyancy Laboratory (NBL), where two training runs were in process for the Shuttle 119 and Hubble Space Telescope (HST) crews. Colonel Collins described the 40-foot-deep pool, which features full-scale mockups of the Shuttle at one end and the ISS at the other end, although the pieces are not necessarily in the same orientation as they are in space, and, next to the pool, an engineering evaluation version of the inflatable lunar habitat.

**EVA Workshop.** Dr. Tom Jones and Eileen Collins attended the EVA workshop, chaired by Senator Harrison Schmitt for the Exploration Systems Mission Directorate (ESMD). The workshop focused on ensuring that lessons learned in decades of EVA experience at NASA are

not lost to the designers of new space suits for the Constellation program. Suit engineers, designers, program managers, and crew members from the Apollo, Skylab, Shuttle, and Constellation programs met in one room to discuss topics such as factors that drive the appearance of both 1960s and current suits (from helmets to boots); possible design improvements; suit features needed for surface exploration (e.g., on the Moon); factors that affect crew mobility and productivity in a spacesuit; crew interfaces with, interactions with, and control of the suit; and the heritage of the Apollo suit design. Workshop participants viewed an Apollo suit, current Shuttle suit, plans for the new generation of Constellation suits, and the small pressurized rover (SPR) that one day may transport these suits and crew members.

**SpaceX Facility Visit.** Colonel Collins noted that members of the Space Operations Committee and the Exploration Committee visited the SpaceX facility at the Space Launch Complex (SLC) 40 at Cape Canaveral. She indicated that the Commercial Orbital Transportation Services (COTS) program used NASA funds to support two companies, SpaceX and Orbital Sciences (previously visited). She reported that Committee members and a SpaceX integration engineer walked to the Falcon 9 rocket and around SLC 40, leased from the Air Force.

Colonel Collins said that 36 SpaceX employees (excluding contractors) are currently working onsite. For the Falcon 9 launch, SpaceX launch and launch control center personnel will total about 100. The Falcon 9 rocket will be integrated in the horizontal in an onsite facility; then can be rolled to the pad, 500 feet away, in 15 minutes; and can be elevated to vertical in 15 minutes.

Colonel Collins stated that the Falcon 9 rocket, which uses liquid oxygen (LOX) and kerosene as propulsion fuel, is scheduled for its first test flight in June or later. In response to Committee member questions, SpaceX confirmed that the mission would achieve (an as-yet unspecified) orbit. She described the Falcon 9 Medium, which has 9 engines, each with 125,000 pounds of thrust (compared to as many as 27 engines on the Falcon 9 Heavy) and a Merlin engine second stage. The firm plans to recover both first and second stages. She suggested NASA might be interested in the Falcon 9 for payloads and mentioned the SpaceX Dragon spacecraft that will carry payloads or possibly launch NASA crews. With the facilities that it now has or is building, SpaceX plans to fly one Falcon 9 per month.

**ISS Status.** Colonel Collins explained that the ISS Program Manager updated the Committee on current ISS capabilities, issues, and growing pains so that it can remain informed and better advise the Council. She displayed the current Shuttle manifest from December 2008 through 2009, reporting that (1) NASA is still on schedule for the transition from a three-person crew to a six-person crew in approximately May; (2) the Agency is flying a total of five Shuttle flights this year, four to the ISS; and (3) the Japanese H-II Transfer Vehicle (HTV) robotic launch, currently scheduled for September from the Tanegashima launch site, is in pretty good shape.

Colonel Collins summarized the anomaly investigation associated with two recent Soyuz missions. Flights in October 2007 and March 2008 suffered ballistic reentries (i.e., higher g loads and steeper descent) when the instrumentation-propulsion module failed to separate from the descent module before reentry. The Russians assembled several teams, including two independent ones, to perform root cause analyses and identified the most likely culprit as pyros that should have fired, but became inactive putatively because of the plasma field generated around the ISS. The Russians developed a fault tree with 27 branches; instituted 6 preventive measures as part of an ongoing response; and successfully flew a March 2008 mission with a

nominal entry. NASA characterized the Russians as very open with U.S. engineers and managers, and described their investigation method as similar to the NASA technique.

The Solar Alpha Rotary Joints (SARJs) sit at the end of the ISS and are important because the solar arrays must generate power before NASA shifts to a six-person crew. Colonel Collins reported that the starboard SARJ began having problems last spring, when flight controllers saw a high current draw and scheduled EVAs that detected metallic debris, coating degradation, and spalling. After further ground-based analysis, EVA crews cleaned and lubricated the race rings and changed out the trundle bearings, restoring the current to previous normal levels. The Agency plans to launch a spare race ring as an ISS onboard spare, but also reserves three options, specifically continuing to run the SARJ as is and monitoring it (the NASA preference); installing an undamaged redundant race ring (in three to five EVAs), but leaving no redundancy; or adding another race ring (in roughly 10 EVAs).

Colonel Collins noted that the ISS needs a periodic reboost to maintain its orbit. NASA can employ five reboost approaches, including using the Progress or the Soyuz when attached to the ISS aft end, employing the European Automated Transfer Vehicle (ATV), using very small engines on the Shuttle to reboost the ISS while the Shuttle is docked, or utilizing the Service Module main engines (which were reboosting when the incident occurred last January). Colonel Collins recounted that incident, when the Russian Mission Control Center uplinked a command that apparently had the wrong filter, producing substantial vibration during the full 2.5-minute burn. The ISS is fitted with accelerometers, so NASA knows the exact loads experienced (particularly in high-load areas such as the solar arrays on the Service Module and truss attachments to the U.S. laboratory and other areas). The Agency concluded that the lifetime of ISS components is unaffected through 2015 and did not change the schedule for upcoming missions. NASA is analyzing the effect of this incident on the anticipated ISS lifetime.

Captain Hauck pointed out that the United States will have the option to review all commands that the Russians uplink to the ISS **before** the uplink, which he deemed a very good sign. Dr. Mark Robinson, Colonel Collins, and Dr. Jones discussed the role of the simulator and humans in the incident and concluded that a process error was more likely, as confirmed by the Space Operations Mission Directorate (SOMD) Associate Administrator. Colonel Collins acknowledged the ongoing uplink issue, but saw a silver lining in the solid, open working relationship between NASA and the Russians and changes in up-front openness, processes, and interactions.

**Commercial Resupply Service.** Colonel Collins addressed the SOMD briefing to the Committee on the Commercial Resupply Service (CRS). She emphasized that CRS and COTS are two different things. COTS (sometimes called Phase 1) is already under way, funded by the seed money granted to SpaceX and Orbital Sciences to conduct their developmental programs and build their hardware. The CRS (Phase 2) is a formal contract that was awarded in December 2008 for the actual delivery of 40 metric tons of cargo to the ISS from 2011 to 2015, after the Shuttle retires, via 12 SpaceX cargo missions and 8 Orbital Sciences cargo missions. The Committee will continue to monitor CRS developments.

**Shuttle Extension Update.** Colonel Collins mentioned that the Space Operations and Exploration committees met with the Shuttle Program Manager to follow up on a Committee request for an update on the NASA Shuttle extension decision process. The Committee waited

because NASA's study was under way and thoroughly reviewing all Shuttle program factors, including cost, facilities, vendors, and workforce impact (civil service and contractors).

Colonel Collins specified that currently each of NASA's three approaches to extending Shuttle operations has major issues. First, if the Shuttle retires at the end of FY10, NASA will face the presumed 5-year gap until 2015 in U.S. human launch capabilities. This approach also creates a workforce issue because management decisions to release or reassign key workers entail the risk that the workers either might not be available or might have lost specialized skills if NASA later recalls them. Second, if NASA flies the Shuttle until 2012, stretching some of the remaining Shuttle missions, the necessary funds might be diverted from the ESMD budget. This approach would financially impair Constellation and significantly delay the program. Third, if NASA extends the Shuttle until 2015, the major impact is not so much on Ares I (crew launch and the ISS), but rather on Ares V, the heavy lift vehicle that will enable return to the Moon. Colonel Collins reported that the SOMD Associate Administrator characterized such a negative impact on Ares V as a big step backward. In addition, the External Tanks (ETs) are the key limiting factor in extending the Shuttle program. With the ETs that NASA now has, the Agency can fly the missions currently on the schedule, with a few more ETs to cover the launches needed for a rescue flight. If NASA extends Shuttle operations beyond the Alphamagnetic Spectrometer Mission, which Congress directed NASA to add, more ETs must be built. Colonel Collins stressed that all of the managers emphasize that once they start working to one of the plans, decisions to change it would require very difficult and costly readjustments.

When Dr. Fortson asked her to comment on the associated risk factors to the crew with any of the considered extensions, Colonel Collins discussed the 1 in 77 loss-of-crew figure, which is based on probabilistic risk assessment (PRA), which draws heavily from the history of previous launches, but does not take into account the many post-Columbia upgrades to the Shuttle. However, the Shuttle is aging, which might make it more risky, and the Columbia Accident Investigation Board (CAIB) recommended flying the Shuttle to finish building the ISS and then ceasing flights. She stated that the Orion follow-on vehicle has an escape system and a protected heat shield and should be a much safer vehicle than Shuttle. Captain Hauck added the appropriate caution that PRA is a great tool for measuring relative risks and perhaps primary risks (i.e., hazards associated with ascent and micrometeoroid and orbital debris damage), but the results are in no way predictive.

Colonel Collins reviewed ISS readiness for a six-person crew, focusing on necessary hardware flown to the ISS, including the advanced resistance exercise device; crew sleep quarters (two on board, two more to arrive on schedule); $CO_2$ removal system; oxygen generation system; waste hygiene compartment; water recovery system; total organic carbon analyzer to test the water to ensure that it is safe to drink; and a galley. She pointed out that each has had issues in the past, but all are either in place for the six-person crew or subject to plans that will resolve the problems in time. The one exception is the Urine Processor Assembly (UPA), which will convert waste water into drinking water for the six-person crew and must be tested and must work. The UPA on board the ISS since last fall is not working, but STS-119 will deliver a new distillation facility and return the other unit to Earth for analysis. She reported that the ISS can support a six-person crew through 2010 by using the water in bags currently on board and scheduled for delivery, but the UPA must be working before the Shuttle retires.

**SMA Case Study Training Brief.** Colonel Collins explained that the Committee was briefed by the JSC Associate Director for Technical, Safety, and Mission Assurance and one of his

managers, who described training for human space flight employees that focuses on lessons learned from past accidents, mainly major accidents like Challenger and Columbia. She noted that the CAIB also asked NASA to focus on lessons learned training, and the materials and supporting documentation that the Committee has seen to date suggest an excellent program that teaches new employees and updates current employees on these incidents and accidents. The Committee concluded that this training is so good and so important that it should be expanded to other areas of human space flight within JSC and at other Centers.

**Recommendation 1.** Colonel Collins explained that this recommendation addresses teaching lessons learned to NASA's human space flight employees and applying those lessons. She shared the Committee's conclusion that, to effectively transfer the hard-won lessons learned in its human space flight workforce, NASA should institute recurring training, using a curriculum based on existing SMA materials. The training program should include lessons learned from the Apollo, Skylab, Mir, Shuttle, and ISS accidents, incidents, and close calls. Dr. Covert gave an example from the underwater NBL some time ago, when an action that worked well in the NBL did not work well in space or in a Houston facility. He emphasized the hard-won lesson that virtual mass will quickly overwhelm the motion of any task to be done, so in space, things will tend to float away from each other—and that the underwater NBL is not the full answer. Colonel Collins agreed with his timely comment. Dr. Milgram suggested an editorial change in the recommendation section on consequences of no action, and Colonel Collins agreed.

**Recommendation 2.** Colonel Collins observed that the Committee's second recommendation is similar to the first, but focuses on documentation and teaching of human space flight lessons learned. The Committee recommends that a portion of the NASA training program should focus on lessons learned from the human space flight missions to retain historical knowledge, as many older employees will be retiring. NASA should document specific major operational lessons learned from human space flight programs. These lessons should be written and presented in a format to facilitate ease of training for the next generation of space workers.

## AERONAUTICS COMMITTEE: REPORT AND DISCUSSION

Dr. Ray Colladay, acting on behalf of the Chair of the Council's Aeronautics Committee, presented the Committee's report, which focused primarily on an in-depth update from the Deputy Associate Administrator of the Aeronautics Research Mission Directorate (ARMD) and on insights into, and discussion about, the considerable progress that the ARMD has made in its ongoing restructuring of aeronautics research and development (R&D) over the last 3 years. The NAC has been instrumental in working closely with and advising the ARMD on this program restructuring.

The Committee held a teleconference with the NASA Aeronautics Program Examiner at the Office of Management and Budget (OMB) and with the Assistant Director for Space and Aeronautics at the Office of Science and Technology Policy, focusing on the current Administration's outlook and attitude toward aeronautics. Support is cyclical, but the Committee was encouraged by these conversations.

In addition, as it has during the last 3 years, the Committee reviewed interactions between NASA and the Federal Aviation Administration (FAA) related to implementing the Next Generation Air Transportation System (NextGen). Such interactions are extremely important because (1) NASA is explicitly responsible for providing much of the R&D and advanced technology needed to

satisfy NextGen requirements; (2) the air traffic management system is under stress, although it has relaxed a bit recently because of the fuel crisis and the slack in the system because of the economic downturn, but that interlude will not last long; and (3) the nation is depending on the NASA program to provide necessary R&D to implement the NextGen traffic system.

**ARMD Update.** Dr. Colladay observed that the ARMD status report detailed the ongoing program and its future direction. The Committee did not spend much time on the slightly delayed National Research Council (NRC) study, initiated in response to a congressional request to analyze the NASA aviation safety research program. Dr. Colladay listed a number of readily available figures on the importance of aviation to commerce and the economy, specifically citing the $3.5 trillion economic impact just from air transportation, moving goods and people around the country and the world. NASA historically has played a major role in providing the technology base that enables a robust air transportation system.

Just as an example, Dr. Colladay displayed the image of a commercial transport aircraft, marking the technologies with a pedigree that traces back to NASA R&D over the last 30 years. Many such technologies evolved from NASA's Aircraft Energy Efficiency Program, created in response to the last energy crisis in the 1970s. NASA did not (and does not) design applications, but rather collaborates with industry and universities to enhance the fundamental understanding that leads to these types of improvements. Industry then captures useful technical advances through a complicated technology transfer process and applies them to commercial products. This same pattern of NASA technology transfer is evidenced in general aviation, military aircraft, rotorcrafts, and even tilt rotors. To illustrate the time required for technologies to evolve, Dr. Colladay cited the NASA XV-15 airplane, which had a 40-year development cycle, but proved that technologies sometimes can be developed in a relatively short timeframe (e.g., 10 years instead of decades). Dr. Eugene Covert agreed, noting a dislike for the word "breakthrough," which overlooks the long time interval between ideas and development.

Dr. Colladay reported that to sustain NASA's accomplishments over the last 20 to 40 years, the Agency totally restructured the entire program 3 years ago, as discussed at previous meetings. Partially as a response to constrained resources, this restructuring refocused the program on fundamental knowledge because some complex interactions are so involved and complicated that they require a renewed understanding of relevant physics and underlying basic principles. The reorganized program was and is producing positive results in fundamental research. Over the last year, the Council and the Committee have stressed the same concept: future gains depend on systems-level research and on an understanding of complex multidisciplinary interactions (e.g., propulsion airframe integration, complex aerodynamics, combustion details relevant to noise or emissions). About a year ago, the Committee recommended that the ARMD consider defining projects that would exploit fundamental research program results and carry them to test beds and hardware in a multidisciplinary research effort to explore such interactions. Many candidate programs have been reviewed and scrubbed, and the Committee views environmentally responsible aviation (ERA) as one of the first candidates that is timely and particularly important to overall environmental concerns, fuel efficiency, and energy conservation.

**Environmentally Responsible Aviation.** The issue here is the impact of an expected three-fold increase in air transportation worldwide over the next 30 years. Regardless of the look of future aircraft, they must be safe, efficient, and friendly to the environment, for example, by decreasing noise in and around airports; reducing NOX, $CO_2$, and greenhouse gas emissions; and developing alternative fuels and lowering fuel consumption). In response to a question about

listing water as an emission, Dr. Ilan Kroo reported that releasing water vapor at low altitudes is fine, but depositing it in the stratosphere has more significant impacts because water vapor actually ranks as a very significant greenhouse gas at high altitudes, where it can form con trails and cause serious cloud formation.

Dr. Colladay explained that the ERA program at a high level is broad based; focused on vehicle advances and NextGen operations; and involves human factors, avionics, and all aspects of vehicle operations, including test beds to explore and evaluate different concepts. Dr. Colladay cited a few future vehicle possibilities, such as a blended wing body architecture with unducted fan engines (i.e., turboprops). The advanced turboprops that NASA has been investigating for years are now attracting industry interest because of energy efficiency and low fuel consumption. In any event, the future vehicle will evolve from technology resulting from the R&D program. As Dr. Colladay declared, the goal is a 20 to 50 percent reduction in fuel consumption for NextGen transport aircraft, lower emissions, and reduced noise. The key is accomplishing all of those objectives at once by using systems-level research.

If the Committee found any fault in the NASA program reformulation, which overhauled the ongoing R&D program at NASA Centers and in universities and industry, it was in the rollout. NASA did not bring stakeholders together to collaboratively construct the new program, and this failure to cultivate ownership across the aeronautics R&D community hindered the rollout.

**Recommendation.** The Aeronautics Committee recommends that the Council form an ad hoc task force under the auspices of the Aeronautics Committee to provide external community input for the formulation of the ERA initiative. NASA is now advancing program development internally by assembling a straw man at Langley Research Center, Ames Research Center, and Glenn Research Center. Dr. Colladay reported that this straw man is well thought out and well conceived and has the elements that NASA thinks are important based on progress in the fundamental research program, but the Agency needs to obtain input from universities and from industry partners that will collaborate in the effort once approved.

Dr. Colladay emphasized that the recommended task force—composed of roughly 20 people from universities, industry, the FAA, and the Department of Defense (DoD)—must be formed promptly to fit into the Agency's FY11 internal budget cycle. The Committee suggested that Dr. Kroo chair the task force, which should hold its first meeting in March, with subsequent follow-ups to ensure that NASA understands its recommendations. The goal is for the Agency to receive independent feedback, process it, modify the program, report to the task force, and obtain closure by mid-June to accommodate the NASA budget cycle.

## EXPLORATION COMMITTEE: REPORT AND DISCUSSION

Lieutenant General James Abrahamson, Chair of the Council's Exploration Committee, presented its report, which focused on joint briefings with the Space Operations Committee and the Science Committee as well as some advice from the Aeronautics Committee, an update on ESMD activities, COTS progress, and a report from the ad hoc Biomedical Committee.

General Abrahamson introduced Mr. John Frost from the Aerospace Safety Advisory Panel (ASAP), citing excellent ASAP work over the years and the potential for the ASAP and the Council to work more closely. Mr. Frost thanked the Council for the opportunity and briefly explained that the ASAP, created in 1967 to oversee safety after the Apollo fire, is the other NASA Federal Advisory Committee Act body. Congress recently expanded that mandate,

requiring the ASAP not only to advise the Administrator, but also to report annually to Congress. He explained that the ASAP is very small, less than 10 members, and very narrow, dealing strictly in the safety of NASA operations, including flight, industrial, and public safety. He was surprised that the Council and the ASAP are asking almost the same questions, although for slightly different reasons, about the same issues (e.g., lessons learned, workforce transition and its impact on safety, exploration and operations, and research for future aeronautics safety).

**ESMD Status.** General Abrahamson noted that NASA is moving well beyond issuing contracts and coordinating requirements into testing for Constellation hardware, software, and overall integration. General Abrahamson then observed that, at some point, changes to plans can become very expensive and counterproductive. General Abrahamson observed that the ESMD Associate Administrator described this Constellation phase as the season of system design reviews (SDRs) to be coordinated. An early and long-standing Committee activity is examining contract and requirements documentation and their impact across various projects. The Committee is delighted with the tremendous progress that ESMD and the Office of Safety and Mission Assurance (OSMA) have made in making such requirements work. After sampling various activities in separate Headquarters review programs, the Committee concluded that the Constellation program has moved to a resynchronization effort and compliments NASA on its job on a vital project, the baseline resynchronization last year and its implementation in out-of-phase areas. For example, an Orion weight problem is reflected into the Ares I, Ares V, and science programs and into the Altair (Moon ascent and descent vehicle) design, so each is developing very complex interfaces.

General Abrahamson reported that the Ares I has advanced from preliminary design review, completing board reviews and scheduling an initial launch this summer. Some hardware already is in place at KSC, and the J-2X critical design review has begun.

General Abrahamson remarked on the presence of the lunar electric rover in President Obama's inaugural parade, a first for NASA that marks political consciousness of the Agency at an important level. NASA now is deep into testing, including the Aerojet contract for the critical thrust LOX-methane ascent stage engine. He was reassured that NASA is moving beyond the vehicle program into the lunar program itself, including integrating the rover's lunar ice prospecting drill and demonstrating the suit-port concept.

General Abrahamson recapped the Lunar Crater Observation and Sensing Satellite (LCROSS) initial launch efforts, including integration readiness reviews, thermal vacuum testing, and balancing analyses and studies that are coming together well.

**COTS.** Dr. John Logsdon explained that in the COTS program structure, ESMD manages the capability demonstration program, and SOMD manages the operational program after capability is demonstrated. He addressed the COTS capability demonstration by two companies, SpaceX and Orbital Sciences Corporation, which signed Space Act Agreements (SAAs), not traditional contracts, with NASA.

***SpaceX.*** Dr. Logsdon and Mr. Don Fraser joined four Space Operations Committee members to visit the SpaceX facility at Space Launch Complex 40 and observe the difference in style of the small commercial operation compared to the more familiar business approach of NASA and United Launch Alliance. SpaceX has nearly demolished the Titan IV complex, has assembled four lightning towers, and is building the integration facility. The vehicle finished its fit tests and is on the pad.

Dr. Logsdon reported that the COTS demonstration will use the Falcon 9, an approximately 1.1 million pound first stage thrust vehicle that approaches the 1.5 million pound Apollo-era Saturn 1B. SpaceX has two Falcon 9 models, a cargo carrier and, using the same mold line, a sizable crew carrier (if developed, it should carry six or seven crew members). SpaceX has nearly completed fabrication of the demonstration Dragon crew spacecraft, which is recoverable, providing down-mass as well as up-mass to the ISS of around 1,300 kg. NASA has committed $278 million to the cargo demonstration, and the SAA includes a so-called Option D, demonstration of crew carrying, which NASA has not funded in its current budget.

The SpaceX COTS program includes 22 milestones, and SpaceX has met milestone 13 and used $224 million of NASA funds. The rest of its program is funded by DoD contracts and personal wealth of the chairman of the board. SpaceX has three demonstration flights scheduled (one this summer, one at year end, and the final one to the ISS in March 2010) to complete its COTS program. SpaceX is building most of its components, including the engines and tanks, in the United States. Colonel Collins followed up on a question from the last meeting about SpaceX payloads; future Falcon 1 payloads include RazakSAT, a Malaysian satellite, and the Falcon 9 demonstration launch will carry an MDA payload, Cassiopeia Avanti HYLAS.

***Orbital Sciences Corporation.*** Orbital Sciences uses modified Russian-built engines, originally for the now-disqualified Kistler Rocketplane COTS entry. The Orbital Sciences cargo carrier is based on the miniaturized pressurized logistics module developed by Alenia for the Shuttle, so it includes significant non-U.S. content. National policy is that all U.S. Government missions must fly on U.S. vehicles, and the Taurus II has been certified as a U.S. vehicle and is being qualified to launch from the Wallops Island facility on the Atlantic coast. Colonel Collins and Dr. Logsdon discussed the Wallops orbital access limitation, and Dr. Logsdon observed that the issue is one of trajectory. The vehicle can reach ISS orbit (51.6 degrees) to execute its primary mission, but no east coast facility can access polar orbit. Dr. Logsdon added that one big difference is that an aborted Shuttle mission could land, but expendable launch vehicles with problems allow stages to fall uncontrolled.

Dr. Logsdon stated Orbital Sciences is rolling through the contract milestones after a late start, earning $60 million of a total $170 million committed by NASA. In the current schedule, SpaceX plans three demonstration launches, but only the third goes to the ISS (the second performs proximity operations).

Dr. Logsdon noted that NASA is betting on one of the COTS vehicles working and thus is not contracting with Russia for Progress supply flights to the ISS, so stakes are fairly high. He described SAAs as very different from the traditional NASA-contractor relationship, an experiment in doing business, with NASA as an observer, not a proactive manager supplying closely coupled technical oversight and advice. Dr. Colladay and Dr. Logsdon discussed the need to examine the time gap if neither COTS vehicle meets its milestones and NASA defaults to a foreign vehicle (i.e., Russian Progress, European ATV, or Japanese HTV). General Abrahamson thought that the difference in contracting approaches creates a future dilemma for schedule and potentially for safety because NASA has not taken the traditional approach of dictating quality of parts and the like; if changes are required, funds must be budgeted. He suggested that the ASAP and the Council's committees should monitor and analyze this situation over time.

Dr. Logsdon reported that the ultimate SpaceX goal is carrying crew members into space, but the current Orbital Sciences vehicle is strictly a cargo carrier and does not include a human-carrying capability. General Abrahamson broadened the context, contending that NASA also has this safety issue with other Government-supported efforts (e.g., in Europe and Japan) and thus will face the challenge of the vehicles upgrading to safely approach the ISS for a long time and with a wide range of vehicles. In response to a question from Dr. Robinson, Dr. Logsdon noted that NASA is not investing significant funds in the SpaceX Dragon crew carrier because the Agency does not want to financially commit until it is sure that the Falcon 9 works. As Colonel Collins mentioned, SpaceX has developed a conceptual design for a heavy-lift version of the Falcon 9 with 18 additional engines, but Dr. Logsdon emphasized that the companies are concentrating on their primary SAA goals.

**Ad Hoc Biomedical Committee Report.** General Abrahamson remarked that the Human Research Program (HRP) has sponsored very effective studies, including the isolation and confinement study agreement with the Russians, which encompasses a body of astronaut data that will be important as space operations proceed. The Committee is concerned with variability in NASA's radiation studies and research because standard setting is critical, but difficult when trying to accommodate so much human variability.

Dr. Katz explained that the memorandum of understanding between the National Institutes of Health (NIH) and NASA, signed over a year ago, is designed to enable U.S. and international scientists to take advantage of the ISS as a national and international resource. The NIH will use reasonable efforts to publicize to all of the scientific community the availability of the ISS and will carefully consider the standard review process for well-developed investigator-initiated extramural applications to use the ISS to support the NIH mission, with initial studies focused on unique cell biology experimentation. Dr. Katz said that 10 different NIH institutes will issue a funding opportunity announcement within months. The community can respond once a year, and NIH will fund awards in two phases, a feasibility assessment (first 2 years) and experiments on the ISS (next 3 years). Discussions on transportation costs are under way.

Dr. Katz summarized the ESMD Associate Administrator briefing to the ad hoc Committee on the many milestones, including selecting proposals for life sciences experiments, associated with the Exploration Technology Development Program. To illustrate ISS research equipment being used and types of studies being performed, he cited the use of bioreactors to maintain order while experiments are conducted in various culture apparatuses (e.g., the Advanced Space Experiment Processor and the T-Cell Growth System). Dr. Katz emphasized that the NIH will advertise the availability of such equipment and noted that immunology studies would be interesting because of their collateral relevance to space travel.

Captain Hauck reported that the ad hoc Committee was briefed on the HRP (and its plans for developing resource requirements) by the Chief Technologist of the ESMD Advanced Capabilities Division and that the ad hoc Committee will follow up with a teleconference to update members who could not attend and enable them to pose questions. He reminded the Committee that the Council, on the recommendation of the ad hoc Biomedical Committee, made 12 recommendations to NASA and the HRP. The Chief Technologist will update the Committee on the status of the recommendations during the teleconference.

General Abrahamson declared that one of the interesting ISS experiments under way is the examination of salmonella and staphylococcus (staph). Dr. Katz agreed, but asked whether

enhanced immunogenicity results, that is, whether an enhanced immune response is obtained by using certain types of organisms that have been exposed to space and microgravity. General Abrahamson declared that the experiment is so significant that the Committee should monitor it.

## SCIENCE COMMITTEE: REPORT AND DISCUSSION

Dr. Jack Burns, Chair of the Council's Science Committee, presented its report, which focused on updated science mission data, progress reports on other topics, and future priorities. He declared that this is a wonderful time to be a scientist, particularly one working with NASA space data, because the new data are just extraordinary and pave the way for additional exciting science results in the next few years.

**Hubble Space Telescope.** Dr. Burns noted that only in the last decade have scientists begun to detect planets (350 known to date), all by indirect measurements (i.e., velocity perturbations on parent stars or eclipses that occur with the planet against the disk). He showed an image of the first detection and real image of an extrasolar planet that circles Fomalhaut, a relatively nearby star about 25 light-years away, surrounded by a dust disk. The HST recorded a little blip that 2 years later had moved, just like a planet. Using that orbital motion and Kepler's laws, scientists determined the mass of this Jupiter-class object. Dr. Burns explained that this sensational HST result previews upcoming missions such as Kepler, with the capability and fidelity to detect the first Earth-like object.

**Pulsars.** Dr. Burns reported exciting new results from a joint Department of Energy and NASA mission, the Fermi Gamma-ray Space Telescope (formerly the Gamma-ray Large Area Space Telescope). Dr. Michael Turner described Fermi, which was launched in June 2008. It is one of NASA's space telescopes (including HST, Chandra, and Spitzer Space Telescope) and sees 20 percent of the sky at one time and the entire sky in 3 hours. Focused on the high-energy universe of gamma rays, Fermi is now fully operational and delivering early results. Dr. Turner highlighted a couple of discoveries, including early detection of roughly 30 gamma-ray pulsars (i.e., rapidly spinning neutron stars, some rotating as fast as 100 times a second, with a mass about 1.5 times that of the Sun and a nuclear density). About 1,800 of these pulsars are known, primarily because most emit radio pulses; of the 36 that emit gamma-ray pulses, only 12 emit no radio pulses, an exciting result that theorists do not fully understand. He noted the release next week of the first catalogue of the 204 brightest gamma-ray sources in the universe, some associated with supermassive black holes at galaxy centers.

**Methane on Mars.** Dr. Burns addressed the exciting recent discovery of methane on Mars. On Earth, much of the methane is produced biologically, but also can be generated geologically, so one of the real questions now is the origin of Martian methane. Dr. Bradley Jolliff summarized summer 2003 results based on years of observations from Mauna Kea telescopes. He noted that this result is very spatially restricted and that known destructive processes should prevent such a distribution, but take some 350 years, so this result indicates very recent production. He said that scientists have not observed volcanic geological processes that account for methane production on Mars (as they do on Earth), but the gas can be sequestered in clathrate hydrates minerals (on Mars, methane hydrates), which could destabilize because of a temperature change, for example, causing Mars to "burp" every now and then. The Mars Science Laboratory (MSL) can test from the surface, using mass spectrometers, gas chromatographs, and other equipment. To identify the source or the magnitude of the reservoir, NASA needs assets on the planet or even in orbit.

**MESSENGER.** Dr. Burns reported that the NASA Mercury Surface, Space Environment, Geochemistry, and Ranging (MESSENGER) spacecraft is zeroing in on the planet closest to the Sun, Mercury, to acquire new data about the little-understood planet. Dr. Robinson said that MESSENGER has made two Mercury flybys (a third is scheduled in September) and will go into orbit in March 2011. Noting that these data are now a few months old and in analysis, Dr. Robinson showed a video and indicated that the resolution will improve when MESSENGER is in orbit and the full suite of instruments is collecting data. He described the current reconnaissance view (roughly 500 meters per pixel) after closest approach, when MESSENGER comes across the day-night boundary, the terminator. He reported that one of the striking Mercury surface features is a crater cut by two generations of compressional tectonics, where the crust is under pressure and buckled. Lying in the middle of much smoother and redder terrain, thought to be volcanic plains, the impact crater excavated from depth a material of a different color that tells something about the lateral and vertical heterogeneity of composition within the crust. He concluded that once MESSENGER is in orbit, spectrometers will detect elemental concentrations that can be tied to color data to reveal surface mineralogy and rocks.

**THEMIS.** Dr. Burns declared that THEMIS has produced extraordinary new results on magnetic field reconnections that lead to eruptions that generate the Northern Lights, observed since the time of Aristotle and studied for 300 years. Dr. Charles Kennel showed a view of Earth, the terminator, and the aurora borealis on the night side, as seen by one of the five THEMIS spacecraft. He described the upper atmosphere as much like an old-fashioned cathode ray television screen. That is, deep-space processes accelerate electrons, which travel down the field lines, penetrate the upper atmosphere, and transfer lost energy to atmospheric constituents. Beyond that, the atmosphere is not sufficiently dense to see light from energetic particles accelerated in space, so spacecraft must measure the magnetosphere. However, large-scale events in space are controlled by very small-scale processes, so satellites must be at the right place at the right time. The question is what deep-space events in the magnetic field lines are connected to the aurora, which can be understood only by entering satellite data into numerical computational models that enable visualizations (such as a solar flare animation he showed).

**Polar Regions.** Dr. Burns noted that very recent observations of the north and south poles have produced extraordinary data on sea ice melt as well as melting on continents and large land masses. Dr. Byron Tapley offered three examples of a rich set of data on Earth system dynamics, generated by a suite of NASA satellites. First, he showed a composite image of changes in the extent of sea ice based on satellite observations, mostly remote sensing satellite aerial data. He explained the significance of the advent of satellite-related data, modeling, and historical long-range predictions, which show a fairly rapid acceleration of the long-term trend from around a 5 percent decline in sea ice extent per year to around an 11 percent drop per year. Second, he showed an image of different types of data depicting changes in the Greenland ice sheet mass since the 2002 launch of the Gravity Recovery and Climate Experiment (GRACE) mission. Third, he displayed a composite image of actual mass loss in the Antarctic, inferred from Landsat hyperspectral data and radar data that trend back to around 1978, showing a rapid increase in melting in recent years (from about 100 gigatons per year to 200), contributing about a .5 cm per year sea level rise in the current timeframe. Dr. Tapley reported that IceSat is measuring topography changes over the Antarctic, and GRACE is making similar measurements of the Greenland ice mass.

Dr. Burns concluded that such measurements represent the tip of the iceberg of scientific results streaming in daily from NASA satellites. He cited the exceptional number of planned launches in 2009, including the Lunar Reconnaissance Orbiter (LRO), the Wide-Field Infrared Survey Explorer (WISE) and Kepler extrasolar planet mission spacecraft, the reservicing mission to the HST, the new weather and atmospheric sensing satellites, and the Planck/Hershel telescopes (joint with ESA). In the next few years, scheduled launches include missions such as Juno to Jupiter, MSL, Lunar Atmosphere and Dust Environment Explorer (LADEE), Mars Atmosphere and Volatile Evolution (MAVEN), and Gravity Recovery and Interior Laboratory (GRAIL) to the Moon.

**Mars Science Laboratory.** Dr. Burns reported that MSL is the largest vehicle that NASA has landed on another planetary body—a little larger than a Volkswagen Beetle and an exceptional advance over the current rovers on Mars. He showed an animation of the 2011 MSL landing, citing extraordinary upcoming advances in science and in technology, from new heat shield developments to the new skycrane. One of the mission cost drivers is all of the new technology, but many MSL technologies also are needed for human exploration (e.g., of Mars).

Monitoring growth of scope and costs, the Committee and Planetary Sciences Subcommittee regularly examine MSL mission scientific value and goals. The Committee still endorses this mission because of the unprecedented science advance (e.g., in understanding early solar system processes and whether life existed in early habitable zones). Scientists know Mars once had running water on its surface, and early conditions for life were potentially there, so the extraordinary and very important question, given the extraordinarily harsh Earth conditions in which life exists, is whether the Martian environment could or did support microbial life.

Dr. Burns reported that the Science Mission Directorate (SMD), with the Administrator, recently decided to delay the MSL launch from October 2009 to the second half of 2011. The Science Committee and the Planetary Sciences Subcommittee concur because the on-time delivery and testing to full capabilities of some important major components (e.g., actuators and avionics) cannot be ensured. This prudent launch delay does have cost impacts (as much as $400 million) because of the marching army associated with such large missions. With the 2-year delay, that cost can be spread over four fiscal years, giving NASA the chance to absorb the expense—perhaps by implementing alternative plans for or postponing some upcoming missions, such as the 2016 mission and the upcoming Mars Sample Return. This approach in part stimulated new discussions about a joint mission with the European Space Agency (ESA) in 2016. NASA and ESA have not previously collaborated on Mars missions, so it would be a breakthrough.

**International Lunar Network.** Dr. Burns summarized another Moon mission, the International Lunar Network (ILN) series of landers, under development for only a year from initial concept to the study just completed and published by the Science Definition Team. Currently, four of these so-called ILN anchor nodes, or individual landers, will land (probably three on the near side and one on the far side) and conduct what planetary scientists call network science (e.g., studies of geological and seismic activity). Dr. Burns explained that scientists need to understand how to properly perform such measurements on non-Earth objects, so the Moon is an important test bed for Mars and probably Europa and other solar system bodies. He noted that this approach is new, and nine nations potentially could participate. The ILN landers in the current baseline would use one of the Stirling power generation instruments or devices, but significant work remains, particularly computer modeling and synthetic resolution tests needed to objectively determine optimal network configuration, realistic techniques for taking seismic measurements,

and better cost estimates. Dr. Burns confirmed that the mission is still in a very early phase, and the community has expressed some concerns that NASA is taking seriously. The Committee is impressed with progress on this project, which was only a core of an idea just a year ago.

**Planetary Protection.** Dr. Burns briefly reviewed the Committee's first in-depth session on planetary protection, an area that the Committee believes has been and is important for NASA. He reported that Dr. Ron Atlas, the Chair of the Planetary Sciences Subcommittee; the NASA Planetary Protection Officer; and several colleagues made informative presentations on the Planetary Protection charter and international implications, particularly regarding the Committee on Space Research (COSPAR); some of these international obligations stretch back to the 1967 Outer Space Treaty. Planetary protection is not only about protecting Earth, but also about defending other worlds such as the Moon and Mars from contamination, an important goal for science and human exploration.

**Earth and Space Mission Cost Comparison.** Dr. Burns related that about a year ago, at the request of the SMD Associate Administrator at the time, the Science Committee and the Council commissioned a study on the cost of Earth remote sensing missions (e.g., planetary, astrophysics, and heliophysics missions) versus other space missions. The Committee was briefed on initial study results, which were based on a database of 30 recently completed missions in all areas of Earth sciences. The Committee was struck by the graphic plot of Phase B, C, D costs versus the complexity index, which includes a series of associated variables related to detectors, detector development, and advanced technology necessary for these missions. As scientists have suspected for decades, this plot of cost versus complexity indicates that the more complex a mission is, the more expensive it is. He reported that the new and interesting development is that the rise is not linear; costs and complexity become very nonlinear for very large missions like Chandra, providing a useful quantitative model. The basic conclusion is that Earth sciences missions, whether measured by cost per unit pound or the relationship between any added costs beyond Phase B, are not out of line with other missions when complexity is factored into the comparison. Dr. Burns acknowledged that these are preliminary results, but supported a recommendation that NASA should maintain the database established in this study, adding data for new missions to track these trends over a few years.

**Earth Sciences Decadal Survey Implementation.** Dr. Burns explained that the Earth sciences community completed its first decadal survey a few years ago, but this field is a rapidly moving target. He cited problems with, and overruns in, the National Polar-Orbiting Operational Environmental Satellite System, a joint National Oceanic and Atmospheric Administration, NASA, and Air Force satellite. The economic stimulus bills pending in the House and Senate might include funds for a couple of the new satellites recommended by the decadal survey. The Committee joins the Earth sciences community and the Earth Sciences Subcommittee in fully endorsing a midterm review of this decadal survey, including recommendations and the current funding and missions in the Earth Sciences Division portfolio. Dr. Burns cited language in the 2008 NASA Authorization Act and experience with previous decadal surveys (e.g., astrophysics and planetary sciences) in expecting that such a review will occur.

**Recommendation 1.** Dr. Burns described this recommendation as a lessons learned analysis of large missions. He cited MSL and previous experience with the James Webb Space Telescope and other large flagship missions that indicate significant expansion in the scope and cost of missions from the time that they are conceived in decadal reviews through additional community working groups through decisions at NASA Headquarters. At this stage, the Committee sees the

usefulness of retracing the decision tree process that led missions like MSL to their current status (e.g., the drivers for, and cost implications of, the relevant major technology decisions). Dr. Burns explained that a whole series of studies has been performed in recent years (including one at DoD), particularly on cost growth, so NASA and SMD can compile lessons learned from a number of individual reports, particularly on the pre-Phase B cost estimation; synthesize them; and identify commonalities in a number of the different missions. He noted that because the astrophysics decadal survey is already under way and the planetary sciences decadal review will start next year, the Committee plans to quickly review the initial results of the midterm review at the next meeting, in time to share its insights with the decadal survey teams later in the year.

**Recommendation 2.** The Committee recommends that NASA should continue the planning process for implementing decadal survey recommendations by considering opportunities for collaboration (as great examples, Mars 2016 and the Joint Dark Energy Mission) and factoring them into planning new medium and large missions across the entire SMD portfolio. The Committee suggests that such actions are in the best interests of NASA and the community; not every mission necessarily needs international partners, but NASA should review architectural development and coordination opportunities to ensure that it is reducing redundancy among missions.

The Committee feels that international collaboration will continue to be more and more important in space sciences and Earth sciences, in part because the complexity and costs of these missions are increasing, but also because the international community has grown in technological and scientific stature. Science benefits from international collaborations with ESA, Japan, India, and other nations that develop important advanced technologies.

Dr. Ray Colladay queried whether International Traffic in Arms Regulations (ITAR) restrictions impede this kind of collaboration, and Dr. Burns responded yes, most definitely. The Committee assumed that some progress with ITAR could be made in the next few years given momentum on this issue from the aerospace industry, universities, and NASA as a whole. Dr. Tapley, Dr. Colladay, and General Abrahamson discussed the possibility of a future recommendation.

Dr. Kulcinski asked about plutonium requirements of the ILN Stirling engine technology, and Dr. Burns indicated that the Director of the Planetary Sciences Division has reviewed availability and concluded that reserves are sufficient. Dr. Robinson added that when Russia makes the second plutonium delivery, NASA will have enough plutonium for four ILN landers and one other Discovery or outer planet mission. Ms. Marguerite Broadwell noted that NASA plutonium requirements encompass not only science missions, but also exploration missions such as human exploration of the Moon and the requisite lunar surface activities.

Mr. Ted McPherson revisited the issue of funding costs from delays, calling it a puzzle, although not a new one, that merits attention Agency-wide. He noted that projects often rely on an initial budget estimate that is very speculative because of uncertainties. Subsequent attempts to stop or delay a project are hard, as is aligning the level and timing of funding with the program and technical risk. He said that the default often is to judge investments relative to the initial speculative estimate. Dr. Burns reported that the astrophysics (and likely the planetary sciences) decadal survey is performing separate cost analyses, so better estimates might be available. Mr. McPherson suggested thinking of financing as a capital structure, offering NASA and Congress the opportunity to astutely use available tools to manage and align goals and funding.

## AUDIT AND FINANCE COMMITTEE: REPORT AND DISCUSSION

Mr. Robert Hanisee, Chair of the Council's Audit and Finance Committee, presented its report, which focused on a review of the year-end FY08 audit from the NASA Deputy Chief Financial Officer (DCFO) and grant-by-grant accounting. The Committee, NASA Inspector General (IG), Deputy IG, and auditor from Ernst and Young (E&Y) held a teleconference to discuss the goal of a clean audit opinion. The Committee is participating in assessing program cost estimating, particularly for Constellation, and monitors cost buildups versus budget and estimated total costs.

**FY08 Audit.** Mr. Hanisee explained that in the FY08 audit report, E&Y auditors again included a disclaimer that they could not render an opinion, qualified or unqualified. As in all its reports, E&Y acknowledged substantial progress, but still identified significant weaknesses in financial management processes and systems, citing the same two material weaknesses noted for the past 5 years. The Committee did not expect a clean opinion because of the ongoing problem of accounting and control for property, plant, and equipment (PP&E), the second material weakness. The Committee was disappointed that NASA has not made more progress in financial systems analysis and oversight, the first material weakness. NASA seems to be on the right path, but the Committee questioned E&Y to better understand its call for "continued refinement."

**PP&E.** Mr. Hanisee reminded the Council that the Federal Accounting Standards Advisory Board (FASAB) decided about a year and a half ago that NASA could treat certain legacy assets (e.g., satellites and assets that no longer could be touched or fixed) as R&D development, permitting immediate NASA write-offs during FY06 and FY07 of $13.3 billion of legacy assets, leaving only two remaining issues, the Space Shuttle (on the books for about $1 billion) and the ISS (more than $13 billion). E&Y had declared that it would not issue a clean opinion until legacy asset issues were resolved, but the Office of the IG (OIG) concluded that the cost of recreating an audit trail to enable a PP&E audit was simply too high.

The Committee reported last October that the Headquarters CFO staff had asked FASAB to treat items such as the Shuttle as R&D, but it declined. However, FASAB has adopted a new exposure draft, including breakthrough language that, if adopted, would permit NASA to solve the PP&E issue. General Jim Abrahamson asked whether other agencies confront the same problem. Mr. Montelongo responded that DoD has faced a challenge even more formidable than the one at NASA and also is requesting some of the same relief from bodies like FASAB.

**Financial Systems, Analysis, and Oversight.** Mr. Hanisee noted that the Committee had been lulled by NASA initiatives to correct this problem and by removal in the FY07 audit report (compared to the FY06 report) of the unfunded environmental liabilities reportable condition. The Committee therefore viewed this issue as closed, although the external auditor, E&Y, continued to agitate for validation of the NASA IDEAL software, which has proven to be somewhat unstable. After conversations with the IG, the Committee saw this as a major concern. Mr. Hanisee observed that this problem is exacerbated by E&Y concern about upcoming asbestos remediation at NASA facilities (still under active discussion). E&Y specifically cited NASA infrastructure problems as an obstacle to addressing the asbestos issue because NASA views the IDEAL software as the solution, but E&Y clearly does not. The Committee has not identified the solution to this problem, but concluded that it certainly is solvable and discussed its suggestions at length with the Committee, the NASA CFO, and the DCFO.

Mr. Hanisee reported that the other E&Y financial systems concern, also with a clear path to resolution, is open contracts, including grant accounting, travel, and the Agency overall. Too

many NASA contracts have no remaining funds, but are open for a long time with no closeout. E&Y is correctly concerned that some mischief could result in misapplication of NASA funds. Although NASA is making real progress in new grant accounting, the Committee agrees that NASA needs to close out completed contracts on a timely basis.

Until NASA deals effectively with these two financial systems issues, Mr. Hanisee concluded that eliminating this material weakness will be difficult, although it could be downgraded to a significant deficiency or even a reportable condition at year-end based on some suggestions that Committee members are sharing with the NASA accounting and oversight staff. He explained that the OIG and E&Y suggested (and the Committee agrees) that the Office of the Chief Financial Officer (OCFO) should focus on financial systems, analysis, and oversight issues, which fall under direct OCFO control (in contrast to legacy PP&E). The E&Y auditor said that if FASAB issues this new standard, E&Y will adhere to it, a very hopeful sign.

Mr. Ted McPherson noted the importance of recognizing that as NASA capabilities improve and mature, the IG and outside auditors should be able to work more effectively. The Committee suggested that the CFO, IG, and auditors discuss giving NASA 180 days (January through June), rather than 90 days, to make remediations and improvements in accounting policy, processes, information technology (IT) installations, and systems. The auditors then would sample June data (from about 450 sampling items) rather than March data; NASA simply would roll forward to September 30; and the auditors would focus on certifying the year-end statements.

Mr. McPherson called this an important and positive change this year, moving from validating a process along the way to pursuing a goal of certifying year-end statements. In addition, the IG and E&Y agreed to meet with the Committee in April and July rather than at the end of the year, enabling Committee members to address these issues and lend their weight and support to management rather than perform an after-the-fact review.

**Management of Unobligated Carryover of Funds.** Mr. McPherson described unobligated carryover of funds (UCF) as investing NASA's money on time and noted that NASA has successfully reduced its end-of-the-year UCF in the past 2 years and that budget versus actual spending reports are now available for all NASA elements within 4 days after the end of each month. All numbers roll up from cost elements to responsibility centers, operating centers, and space centers, by project and program (a new enhancement this year), themes, and mission directorate. He noted that NASA has a solid capability for budget formulation and execution and now timely insights from improved management reporting.

Showing a chart of unobligated NASA funds at the end of the last several fiscal years, Mr. McPherson cited NASA's reduction of its UCF this past year to about $.5 billion from more than $2 billion as a result of managing, monitoring, inspecting, and gaining insight into how and at what pace the money is spent. Mr. McPherson illustrated the quality of SOMD management reporting by displaying a dashboard that shows a plan and actuals for different categories of expenses and enables users to click for further details by projects within a line item.

Dr. Katz was struck by the large UCF, which would be astounding in a grant-giving organization like the Centers for Disease Control, and asked about benchmarks at other similar agencies. Mr. McPherson responded that benchmarks would be not running out of funds and not overobligating (and incurring the associated severe penalties), providing a safety valve. He characterized the job as not just investing funds at a reasonable pace, but making the right investments. He

suggested that, based on timely information about expenditures and improved funds control a UCF under 5 percent should be achievable.

**Grant Accounting.** Mr. McPherson confirmed that although the Committee has identified grant accounting as a soft spot, NASA has made real, tangible improvements, most significantly by reviewing and managing grants and by using single grant accounting (i.e., grant-by-grant accounting) rather than simply dispersing a lump sum to an institution. The NASA grant portfolio currently includes 8,000 active single grants, and some funding pools are disaggregated so that NASA can view them as single investments to about 1,000 institutions. The NASA portfolio includes just less than $7 billion in active grants. As part of this process, NASA closed 860 previously active accounts and is reconciling more than 600 single grant accounts.

**NSSC.** Mr. McPherson reported that by the end of the month, the NASA Shared Services Center (NSSC) at the Stennis Space Center would be managing end-of-grant activities, an improvement over the previous approach. He provided a brief update on the NSSC, which handles accounts payable, accounts receivable, travel, and coordination of payroll. NASA has moved a number of those processes (as they stabilize) from the Centers to the NSSC, reducing some Center costs. Mr. McPherson indicated that the current issue with NSSC is its high per-transaction processing cost. The NSSC budget is about $50 million a year, but the Center still has a relatively low transaction volume and an overly high per-transaction expense, so NASA must reduce it by integrating more efficient document handling techniques, adding more volume, or reducing the costs or the work in the NASA Centers where the task was previously performed. NASA also needs to further improve on-time processing to eliminate late payment penalties.

**OCFO Reorganization.** Mr. Montelongo described NASA's financial management picture as brighter than it has ever been. One of the key reasons is NASA leadership over the last 2 years, including the former NASA Administrator and the current NASA CFO and DCFO. To make the OCFO financial management organization more robust and capable, NASA refocused the Business Integration Division and added three divisions, specifically the Systems Division, the Strategic Integration and Policy Division (SIPD), and the Performance Reporting Division.

SIPD is the clearinghouse on policy, training, and initiative representation for the financial management organization, but also focuses on OCFO strategic direction. Responding to a congressional mandate to overlay cost controls and reporting on conference attendance, SIPD is the NASA reporting point of contact, has installed procedures and controls to track attendance and expenditures, and is reporting costs for all conferences to Congress and for NASA-sponsored conferences to the OIG. Dr. Burns observed that this conference attendance constraint has been a huge problem for a number of NASA scientists and engineers this year, demoralizing a staff already under a good deal of pressure, and concluded that the issue should be permanently solved by removal of the restriction. He noted that no evidence indicates excessive conference travel, but incomplete accounting from previous years gave the appearance of a large jump in conference attendance. Dr. Stephen Katz reported NIH experience with the same issue, which was tremendously demoralizing to scientists. NIH stressed the scientists' need to attend specific meetings and the potential advantages of information exchanges among large groups of scientists with professional commonalities. Dr. Burns reported that organizations external to NASA have focused on that strategy, but little progress has been made for several reasons, including a concern that NASA should do a better job of accounting for conference funds and expenditures. The NASA CFO is focused on this issue, is cooperating with the Council in seeking solutions,

and has explained that scientists must attend scientific conferences as an absolutely essential part of their jobs (which might persuade Congress to remove the limit next year).

Mr. Montelongo described another new major division, the Systems Division, which functions as the financial managers' chief information officer (CIO), the internal CIO for the NASA Chief Financial Officer (CFO). He applauded this action, citing the importance of full-time oversight of the design, maintenance, and ownership of the financial management architecture.

**Cost and Schedule Growth and Containment.** Mr. Montelongo reported that the Committee has discussed and revisited the issue of cost and schedule growth and containment with Program Analysis and Evaluation (PA&E), which formally oversees this function within NASA. He indicated that PA&E recognizes the challenge of cost estimating in an uncertain environment. He showed an illustrative PA&E table that summarizes the results of a number of studies over four decades that probed the symptoms and core reasons for cost and schedule growth. PA&E has mirrored the DoD approach, not necessarily as the benchmark or perfect solution, but as a modestly successful template. Mr. Montelongo briefly described NASA changes in policy, governance, and capabilities. First, at the policy level, NASA is requiring projects to develop and maintain a joint set of probabilistic estimates for cost and schedule and requiring programs to budget projects at a 70 percent confidence level and then fund them at least to a 50 percent confidence level (with contingencies to reach 70 percent, as Dr. Charles Kennel noted). Second, to improve governance, NASA is establishing standing review boards to reconcile different cost estimates that arise at the project level and the Agency level. Third, to provide needed capabilities, NASA has been and currently is collecting historical and current project cost data (i.e., a cost analysis data requirements document) as a basis for accurate cost estimating.

Mr. Montelongo described one other PA&E responsibility, reporting cost and schedule performance to external constituencies such as Congress, the Government Accountability Office, and OMB, which all have imposed a number of requirements on NASA that continue to metastasize. On behalf of NASA, PA&E is responding with a more streamlined reporting system that controls frequency, uses common data and information, and can generate reports for both internal and external constituencies.

**Staffing.** Mr. McPherson briefly revisited the staffing issue previously considered by the Committee. OCFO has about 103 authorized positions and is actively recruiting for roughly 10 vacancies. The direct report positions to the NASA CFO and the DCFO are filled, except for acting CFOs at two Centers. Mr. Hanisee confirmed that the NASA CFO has accepted an offer to continue as the Headquarters CFO, a Transition Team decision that the Committee views as wise because the CFO is a tremendous asset.

Mr. Hanisee reported that the Committee had no active recommendations. Although NASA has had two material weaknesses for the last 2 years, the Committee does see a clear way to resolving those over the next year or by the end of the following fiscal year.

## HUMAN CAPITAL COMMITTEE: REPORT AND DISCUSSION

Dr. Gerald Kulcinski, Chair of the Council's Human Capital Committee, presented its report, which focused on the NASA workforce, concentrating on the Cooperative Education (Co-op) program and hiring of freshouts (i.e., entry-level people); informal education metrics; and NASA TV.

**Workforce.** Dr. Kulcinski observed that the current NASA commitment to 10 healthy Centers and a robust program across various disciplines underlies its workforce of about 18,000 full-time equivalents (FTEs)—18,400 after adding part-time employees and students and more than 60,000 after adding roughly 46,000 contractor work-year equivalents (FTEs). The profile includes a large Apollo peak and the post-Challenger peak, but the workforce has been flat for a decade and probably will be flat for the next 4 or 5 years. Breaking down the current workforce, Dr. Kulcinski reported that scientists and engineers compose about 60 percent of the workforce (of which, roughly 90 percent now are engineers, and 10 percent are scientists); professional and administrative workers about 28 percent; and technicians, clerical workers, and others about 12 percent. Dr. Kulcinski noted that OMB set the NASA civil service workforce target at 17,900 FTEs (not including students), so NASA is very close. The Committee sees no cause for concern because the trend is in the right direction. The OMB FTE target applies to the 5-year outlook, so NASA does not expect growth in the overall size of the civil service workforce, although the discipline makeup will change considerably. In addition, Dr. Kulcinski observed that Congress imposed a moratorium on reductions in force, apparently specific only to NASA, in its appropriation bills.

The Committee has reviewed the NASA workforce age distribution at the last several meetings, viewing different snapshots of the same data. In each case, plotting the workforce age during the Apollo era, Shuttle era, and today shows a trend that continues to worsen. The overall average age was 39 for the Apollo era, 44 for the Shuttle era, and now 47 and rising. Thus, the young side of the average age curve is declining alarmingly, which has implications for the workforce in the next 5 to 10 years.

***Co-Ops.*** NASA Co-op program student participants spend time during a summer or semester at NASA Centers. Co-ops constitute the main freshout source of new NASA employees (compared to direct campus recruiting). Dr. Kulcinski reported that each Center tends to hire co-ops locally rather than nationally, prompting the Committee to ask whether this near-exclusive reliance on co-op hiring ensures entry-level personnel culled from the best and brightest nationwide. Dr. Kulcinski suggested an approach that encourages NASA to continue its Co-op program while also expanding recruiting into different areas (not mutually exclusive). NASA has a student loan repayment program for freshouts, and it is both publicized and utilized.

Dr. Kulcinski reviewed the number (not percentage) of new hires during the last 5 years, breaking it down into entry level (largely Co-ops), midlevel (experienced personnel, frequently contractor employees); and senior level (recruited executives). Dr. Owen Garriott noted that mid-level local hires (mostly from contractors) previously at least equaled, but now exceed, the civil service as a source of new hires, and Dr. Kulcinski agreed that a higher fraction of new hires now resides in the mid-level than in the entry level.

***Workforce Observations.*** The Human Capital Committee concluded that it had insufficient data to support recommendations, but observed that the Office of Human Capital Management (OHCM) should determine if the Co-op program as currently implemented is the best way to expand recruitment and selection of the best and brightest hires on a national scale.

Committee conversations with OHCM staff identified other hiring culture observations. First, managers are reticent to hire young people to do jobs that the managers themselves did when they were hired at the same age. Second, Dr. Kulcinski cited staff concerns that tactical hiring versus strategic hiring favors increasing age demographics (i.e., immediate tasks feed the

tendency to hire from the mid-level pool, the contractors rather than the freshouts). Third, Dr. Kulcinski explained the severe local financial impact of workforce reductions, specifically in areas such as Brevard County, because workers are less likely to accept employment if the local area does not offer a large reservoir of other employment opportunities (e.g., KSC, Stennis Space Center, Dryden Flight Center, and maybe even Marshall Space Flight Center).

Mr. McPherson declared that human capital diagnostics, analytics, constraints, and attitudes have been known for some time, but the more specific core issue is attracting and retaining the best available talent in the mix that NASA needs. He suggested a briefing on top actions, solutions, or changed approaches that respond to the situation, stressing the need for tangible evidence of change so that the Committee can identify missing elements. He cited examples of recruiting approaches, such as the student loan repayment program, targeted recruiting on campuses, and use of executive recruiting firms approved by the General Services Administration. Mr. McPherson concluded that the Committee needs a concise, focused summary of such in-place or potential options to enhance the productivity of the NASA employment dollar. Mr. Montelongo identified another dimension, the composition and diversity (e.g., gender, ethnicity) of the workforce, not just its brainpower. Dr. Kulcinski agreed, admitting that the Committee's on-point briefings from the Office of Diversity almost a year ago did not raise red flags because initiatives seemed to be on track, but the Committee should revisit the issue and assess progress.

Mr. Frost noted that the ASAP has been concerned about this problem for years and believes that a root cause is the Center-centric (rather than Agency-focused) approach to managing workforce. The ASAP has seen major changes in the last year, including improvements in the workforce management plan, which has evolved from 10 Center plans to a national recruitment strategy.

**NASA TV.** The Committee acknowledged that the Acting Assistant Administrator for Public Affairs delivered a concise history of NASA TV and current issues, but did not address the Committee's concerns about the plan that NASA described to its members in October 2008. The Committee is wrestling with the effects of high turnover, lack of continuity, and repeatedly changing points of contact in NASA's strategic communications leadership. The Committee readdressed a previous recommendation (HC-08-01), originally filed in April and modified in July, that an outside organization should be contracted to evaluate the current effectiveness of NASA TV and to recommend a rationale and set of themes for its continuance. The NASA Public Affairs Office responded in October that an outside analysis was not needed and that any external evaluation should be conducted after NASA implemented the changes specified in its internal plan. As Dr. Kulcinski explained, the problem is that the Committee has not seen any progress in implementing that plan. The Committee should revisit this issue and assess its status.

**Informal Education Metrics.** Dr. Kulcinski reported that OMB needs a set of meaningful metrics to assess education funding effectiveness, which sounds simple, but educational progress is not easy to measure for NASA or other agencies. OMB uses definitions like outcome, output, and efficiency, but these terms are somewhat obscure when applied to education.

The Committee specifically addressed informal science education, that is, nontraditional rather than institutional education (e.g., when someone visits a museum, the issue is how to measure the effectiveness of that experience and the efficiency of the funding). NASA is having difficulty devising a uniformly accepted set of metrics, and the Agency does not have the in-house resources necessary to measure the impact of informal learning experiences. The NASA Office of Education therefore asked the Human Capital Committee to help in constructing

meaningful metrics that match OMB requirements and definitions. Dr. Fortson confirmed that assessing learning in the formal education system is already difficult, but measuring learning while controlling variables is much more challenging in the free choice environment often associated with informal education systems. The Committee concluded that NASA does not have the resources to accomplish—and does not want to burden grantees with—assessing informal learning given the framework and metrics that OMB has provided. However, the National Science Foundation (NSF) has a line of investigation into learning and informal education, so NASA and NSF could potentially agree to work together to define the learning metrics, leaving NASA to focus on quantifiable metrics (e.g., number of museum visitors or Web hits). General Abrahamson initiated a discussion with Dr. Kulcinski, Dr. James Milgram, Mr. McPherson, and Dr. Fortson about the ability of the Executive Branch and other agencies to measure program and funding effectiveness. Dr. Fortson reported that education metrics are a work in progress and the Committee has just begun to examine the individual and joint work that the Department of Education, NASA, and NSF have undertaken on education metrics overall in response to OMB.

## CLOSING REMARKS

At this meeting, the Council produced three recommendations, and Dr. Ford confirmed that they would all be submitted to NASA. Dr. Ford revisited the Aeronautics Committee recommendation for a modification that, as Dr. Colladay said, preserved the outreach intent, but changed the language slightly from an "ad hoc task force" to a "two-step workshop."

Dr. Ford opened the meeting to comments from the public. Mark Allen from NASA asked Dr. Kulcinski about the precipitous dropoff in civil service hiring of young candidates and whether contractors tended to hire and retain younger people whom the Government sometimes later hires, so contractors perhaps serve as a pipeline to NASA for these professionals. Dr. Kulcinski agreed, but noted that the Committee does not have supporting data. Dr. Ford reported that presentations at an earlier meeting indicated that many Agency programs need experience and are hiring candidates who were employed as freshouts by contractors, but now are joining NASA as mid-career professionals, particularly in Constellation.

Dr. Ford thanked the Council members for their work and the members of the public for their attendance and then adjourned the meeting.

# APPENDIX A

## NASA ADVISORY COUNCIL
## Hilton Cocoa Beach Oceanfront
## Sea Oats Room
## Cocoa Beach, Florida
## February 5, 2009

### MEETING AGENDA

| | | |
|---|---|---|
| 8:00 a.m. – 8:15 a.m. | Opening Remarks | Dr. Kenneth Ford |
| 8:15 a.m. – 9:15 a.m. | Space Operations Committee | Colonel Eileen Collins |
| 9:15 a.m. – 10:15 a.m. | Aeronautics Committee | Dr. Ray Colladay |
| 10:15 a.m. – 10:30 a.m. | *Break* | |
| 10:30 a.m. – 11:30 a.m. | Exploration Committee | General James Abrahamson |
| *11:30 a.m. – 12:30 p.m.* | *Lunch (Council Only)* | |
| 12:30 p.m. – 1:30 p.m. | Science Committee | Dr. Jack Burns |
| 1:30 p.m. – 2:30 p.m. | Audit and Finance Committee | Mr. Bob Hanisee |
| 2:30 p.m. – 2:45 p.m. | Break | |
| 2:45 p.m. – 3:45 p.m. | Human Capital Committee | Dr. Gerald Kulcinski |
| 3:45 p.m. – 4:30 p.m. | Final Comments | Dr. Kenneth Ford |
| 4:30 p.m. | Adjourn | |

# APPENDIX B

## NASA ADVISORY COUNCIL
## Members and Committees
## February 5, 2009

| Role/Group | Members |
|---|---|
| Chair | • **Hon. Kenneth M. Ford**, Ph.D., Founder and Director, Florida Institute for Human and Machine Cognition |
| Aeronautics Committee | • ***Acting Chair (Ex Officio)***: **Dr. Raymond S. Colladay**, Chair, Aeronautics and Space Engineering Board, National Academies<br>• **Dr. Eugene E. Covert**, T. Wilson Professor of Aeronautics (Emeritus), Department of Aeronautics and Astronautics, Massachusetts Institute of Technology<br>• **Dr. Ilan Kroo**, Professor, Aeronautics and Astronautics, Stanford University<br>• **Dr. John Sullivan**, Professor, Aeronautics and Astronautics, and Director, Center for Advanced Manufacturing, Purdue University |
| Audit and Finance Committee | • ***Chair***: **Mr. Robert M. Hanisee**, CFA; Managing Director, Trust Company of the West<br>• **Hon. Edward R. "Ted" McPherson**, Chief Executive Officer, InterSolve Group, Inc.<br>• **Hon. Michael Montelongo**, Senior Vice President, Strategic Marketing, Sodexho, Inc. |
| Exploration Committee | • ***Chair***: **Lieutenant General James A. Abrahamson**, USAF (Ret.)<br>• **Hon. Donald C. Fraser**, Ph.D., Member of the Board, DRS Technologies<br>• **Captain Frederick H. "Rick" Hauck**, USN (Ret.); NASA Shuttle Pilot and Commander (Ret.)<br>• **Dr. Stephen I. Katz**, M.D., Ph.D.; Director, National Institute of Arthritis and Musculoskeletal and Skin Diseases<br>• **Dr. Alexander H. Levis**, Professor, Head of the System Architectures Laboratory, Volgenau School of Information Technology and Engineering, George Mason University<br>• **Dr. John M. Logsdon**, Charles A. Lindbergh Chair in Aerospace History, National Air and Space Museum, Smithsonian Institution |
| Human Capital Committee | • ***Chair***: **Dr. Gerald L. Kulcinski**, Associate Dean for Research, College of Engineering, University of Wisconsin-Madison<br>• **Dr. Lucy F. Fortson**, Vice President for Research, Adler Planetarium and Astronomy Museum (Chicago)<br>• **Dr. Ioannis Miaoulis**, President and Director, Museum of Science (Boston)<br>• **Dr. R. James Milgram**, Professor, Department of Mathematics, Stanford University |
| Science Committee | • ***Chair***: **Dr. Jack O. Burns**, Professor, Department of Astrophysical and Planetary Sciences, University of Colorado; Vice President (Emeritus), Academic Affairs and Research, University of Colorado System<br>• **Dr. Bradley L. Jolliff**, Research Associate Professor, Department of Earth and Planetary Sciences, Washington University (St. Louis)<br>• **Dr. Mark S. Robinson**, Professor, School of Earth and Space Exploration, Arizona State University<br>• **Dr. Byron D. Tapley**, Director, Center for Space Research, and Professor, Aerospace Engineering, University of Texas at Austin<br>• **Dr. Michael Turner**, Bruce V. and Diana M. Rauner Distinguished Service Professor, University of Chicago |

| Role/Group | Members |
|---|---|
| Space Operations Committee | • ***Chair*: Colonel Eileen M. Collins**, Aerospace Consultant; President, Space Presentations, LLC; USAF (Ret.); NASA Shuttle Pilot and Commander (Ret.)<br>• **Dr. Owen K. Garriott**, Adjunct Professor, Department of Biological Sciences, University of Alabama in Huntsville; NASA Skylab and Spacelab Astronaut (Ret.)<br>• **Mr. Jay H. Greene**, Aerospace Engineer<br>• **Dr. Thomas D. Jones**, Consultant; USAF (Ret.); NASA Shuttle Astronaut (Ret.) |
| Ex Officio | • **Dr. Charles F. Kennel**, Chair, Space Studies Board, National Academies; Director, Scripps Institute of Oceanography |
| Not in Attendance | • **Dr. Stephen P. "Pat" Condon**, Aerospace Consultant<br>• **Dr. David Longnecker**, M.D.; Chair, Committee on Aerospace Medicine and the Medicine of Extreme Environments, Institute of Medicine, National Academies<br>• **General Lester L. Lyles**, USAF (Ret.); Consultant, The Lyles Group<br>• **Rear Admiral Benjamin F. Montoya**, USN (Ret.); CEO, Smart Systems Technologies, Inc.<br>• **Dr. Howard J. Stanislawski**, Partner, Sidley Austin Brown & Wood, LLP |

# APPENDIX C

## NASA ADVISORY COUNCIL
## Hilton Cocoa Beach Oceanfront, Cocoa Beach, Florida
## February 5, 2009

### ATTENDEES

| Council Members | NASA Attendees | | Other Attendees | |
|---|---|---|---|---|
| Abrahamson, James A. | Allen, Marc | HQ, SMD | Brandow, Heidi | ITT Corporation |
| Burns, Jack | Bartino, Dave | KSC | Chafer, Sallie Birket | NASA consultant, meeting recorder |
| Colladay, Raymond S. | Broadwell, Marguerite | HQ | Faulconer, Walt | Applied Physics Laboratory |
| Collins, Eileen | Ellis, Nicole | OIG | Halvorson, Todd | Florida Today |
| Covert, Eugene | Frost, John | ASAP | Heard, Marsh | EDC |
| Ford, Kenneth | Green, Thomas | HQ, OCFO | Ketcham, Dale | SRTI/Univ. of Central Florida |
| Fortson, Lucy | Keaton, Jacob | HQ | Laffitte, Adrian | Lockheed Martin Corporation |
| Fraser, Donald C. | King, Marla | HQ | Lamm, Tracy | Pratt & Whitney Rocketdyne |
| Garriott, Owen | Ladwig, Alan | HQ | Solid, Lee | EDC |
| Greene, Jay | Mango, Ed | KSC | | |
| Hanisee, Robert M. | McGinnis, Richard | HQ | | |
| Hauck, Rick | Merkle, Lori | HQ | | |
| Jolliff, Bradley L. | Ostrach, Louis | HQ, ESMD | | |
| Jones, Thomas | Parham, Jane | HQ, ESMD | | |
| Katz, Stephen | Peterson, Frank | HQ | | |
| Kennel, Charles F. | Quincy, Charlie | KSC | | |
| Kroo, Ilan | Rausch, Diane | HQ, OER | | |
| Kulcinski, Gerald L. | Riesco, Melissa | HQ | | |
| Levis, Alex | Simpkins, Pat | KSC | | |
| Logsdon, John | | | | |
| McPherson, Edward R. | | | | |
| Miaoulis, Ioannis | | | | |
| Milgram, R. James | | | | |
| Montelongo, Michael | | | | |
| Robinson, Mark S. | | | | |
| Sullivan, John | | | | |
| Tapley, Byron | | | | |
| Turner, Michael | | | | |

# APPENDIX D

## NASA ADVISORY COUNCIL
## Hilton Cocoa Beach Oceanfront
## Cocoa Beach, Florida
## February 5, 2009

### MEETING PRESENTATION MATERIALS

**List of Committee Presentation Materials***

1. Space Operations Committee Report [Collins]
2. Aeronautics Committee Report to the NASA Advisory Council [Colladay]
3. Exploration Committee and Ad Hoc Biomedical Committee Report [Abrahamson]
4. Science Committee Presentation to NAC Plenary [Burns]
5. Audit and Finance Committee [Hanisee]
6. Human Capital Committee Report [Kulcinski]

**Other Materials Distributed at the Meeting**

1. NASA Advisory Council, Meeting Minutes, October 16, 2008
2. NASA Responses to NASA Advisory Council 2008 Recommendations

* Presentations and other materials distributed at the quarterly NAC meeting are available (1) online at http://www.nasa.gov/nac and (2) on file at NASA Headquarters, OER/ACMD, 300 E Street SW, Washington, DC 20546.